



California
Energy
Alliance

**Case Studies in
Occupancy Based Unified Controls
and Battery Storage
California State University
Dominguez Hills**

Kenneth Seeton Central Plant May 13, 2020

Why Occupancy Based Controls?

- Considerable energy savings over Schedule Based
- Reduced GHG for gas portion
- Good for spaces with flexible or variable occupancy



Occupancy Based Lighting Controls

- Well understood
- Widely implemented
- Required in T24
- Sensors are ubiquitous and available



Opportunities

- Make HVAC Occupancy based, like Lighting
- Use Available sensors instead of redundant ones
- Unify reporting & controls through BacNet



Challenges

- Occ based HVAC not common yet
- Difficult to cross silos to integrate controls in different systems
- Resolving zone issues



New Center for Science & Innovation



New Center for Science & Innovation



91,000 gsf
Biology, STEM, Chemistry
Multiple Fume hoods

Complete, Commissioned
Unoccupied



Welch Hall



Welch Hall



Retrofit
179,222 gsf
4 stories, 496 rooms
opened 2002

Police station, I.T., Server Room
President, VPs, Provost
Lecture Hall



Project Requirements

- Meet or Exceed code for EUI
- Low Carbon Footprint
- Future proof - visible upgrade path
- Multi-purpose technology
- LEED Gold (Platinum)



Basis of Controls Design

- Lighting to Communicate with HVAC
- Submeters bring data into BAS (through BACnet)
- Control individual light levels & HVAC in every individual office for max comfort & productivity



How We Did It

- Slowly work on creating campus standards.
(This is not done overnight)
- Getting Mechanical Design Engineer to buy in to our vision so BOD is built around what you want and not around what they are used to
- Showing possible LEED points through using smarter controls



CSUDH

- EE_Extended Education
- LCH_LaCorte Hall
 - LaCorte Hall
 - 1st Floor
 - 2nd Floor
 - 3rd Floor
- Library North
- NCIS
 - NCIS
 - Floor 1
 - Floor 2
 - Floor 3
- NSM_Natural Science and
- Parking Lots
- SAC_CP_Tunnels_PP
- SBS and EAC
- WH_Welch Hall
 - Welch Hall
 - WH 1st Floor
 - WH 2nd Floor
 - WH 3rd Floor Hall
 - WH 4th Floor Hall



Lighting Zones to match VAV Zones



Status D

Stop Restart Close

Native Object Name	Identifier
CSUDH/NCIS/NCIS/Floor 3/ENVAV3.06[118]	Device-2133118
CSUDH/NCIS/NCIS/Floor 3/ENVAV3.05[117]	Device-2133117
CSUDH/NCIS/NCIS/Floor 3/ENVAV3.04[116]	Device-2133116
CSUDH/NCIS/NCIS/Floor 3/ENVAV3.03[115]	Device-2133115
CSUDH/NCIS/NCIS/Floor 3/ENVAV3.02[114]	Device-2133114
CSUDH/NCIS/NCIS/Floor 3/ENVAV3.01[113]	Device-2133113
E-Mon Meter (89)	Device-89
E-Mon Meter (88)	Device-88
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.15[306]	Device-2101306
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.16[307]	Device-2101307
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.13[305]	Device-2101305
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.5[299]	Device-2101299
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.3[297]	Device-2101297
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.2[296]	Device-2101296
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.12[304]	Device-2101304
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.10[303]	Device-2101303
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.8[302]	Device-2101302
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.21[311]	Device-2101311
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.7[301]	Device-2101301
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.6[300]	Device-2101300
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.20[310]	Device-2101310
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.19[309]	Device-2101309
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.17[308]	Device-2101308
CSUDH/WH_Welch Hall/Welch Hall/WH 4th Floor Hall/WHEN4.4[298]	Device-2101298
CSUDH/SAC_CP_Tunnels_PP/SAC-2/Classrooms/2101 LED[58]	Device-2123058
CSUDH/WH_Welch Hall/Welch Hall/WH 1st Floor/Classrooms[11]	Device-2107011
CSUDH/WH_Welch Hall/Welch Hall/WH 1st Floor/Office[12]	Device-2107012
CSUDH/WH_Welch Hall/Welch Hall/WH 1st Floor/Hallways[10]	Device-2107010
E-Mon Meter (96)	Device-96
E-Mon Meter (100)	Device-100
E-Mon Meter (97)	Device-97
SWBD MSA SECTION 1PXM 2000	Device-102
PXMP Meter Base - 107	Device-107
SWBD MSA SECTION 2 PXMP	Device-106
SWBD MSA SECTION 1PXM 2000	Device-103
CSUDH/NCIS/NCIS/Floor 3/ENVVS3.23[133]	Device-2133133
CSUDH/NCIS/NCIS/Floor 3/ENVVS3.22[134]	Device-2133134
CSUDH/NCIS/NCIS/Floor 3/ENVVS3.20[132]	Device-2133132
CSUDH/NCIS/NCIS/Floor 3/ENVVS3.19[131]	Device-2133131
CSUDH/NCIS/NCIS/Floor 3/ENVVS3.18[130]	Device-2133130
CSUDH/NCIS/NCIS/Floor 3/ENVVS3.17[129]	Device-2133129

Native Object Name	Identifier	Name
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.01[68]	Device-2131068	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.02[69]	Device-2131069	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.03[70]	Device-2131070	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.04[71]	Device-2131071	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.05[72]	Device-2131072	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.06[73]	Device-2131073	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.07[74]	Device-2131074	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVAV1.08[75]	Device-2131075	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.01[137]	Device-2131137	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.02[138]	Device-2131138	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.03[139]	Device-2131139	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.04[140]	Device-2131140	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.05[141]	Device-2131141	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.06[142]	Device-2131142	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.07[143]	Device-2131143	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.08[144]	Device-2131144	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.09[76]	Device-2131076	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.10[77]	Device-2131077	CSUDH/NCIS/NCIS/Floor 1/EN
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CSUDH/NCIS/NCIS/Floor 1/ENVVS1.13[80]	Device-2131080	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.14[81]	Device-2131081	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 1/ENVVS1.15[82]	Device-2131082	CSUDH/NCIS/NCIS/Floor 1/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.01[83]	Device-2132083	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.02[84]	Device-2132084	CSUDH/NCIS/NCIS/Floor 2/EN
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CSUDH/NCIS/NCIS/Floor 2/ENVAV2.06[88]	Device-2132088	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.07[89]	Device-2132089	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.08[90]	Device-2132090	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.09[91]	Device-2132091	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.10[92]	Device-2132092	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVAV2.11[93]	Device-2132093	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVVS2.01[152]	Device-2132152	CSUDH/NCIS/NCIS/Floor 2/EN
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CSUDH/NCIS/NCIS/Floor 2/ENVVS2.04[155]	Device-2132155	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVVS2.05[156]	Device-2132156	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVVS2.06[157]	Device-2132157	CSUDH/NCIS/NCIS/Floor 2/EN
CSUDH/NCIS/NCIS/Floor 2/ENVVS2.07[158]	Device-2132158	CSUDH/NCIS/NCIS/Floor 2/EN



Tailored Summary Summary

Available Tailored Summaries

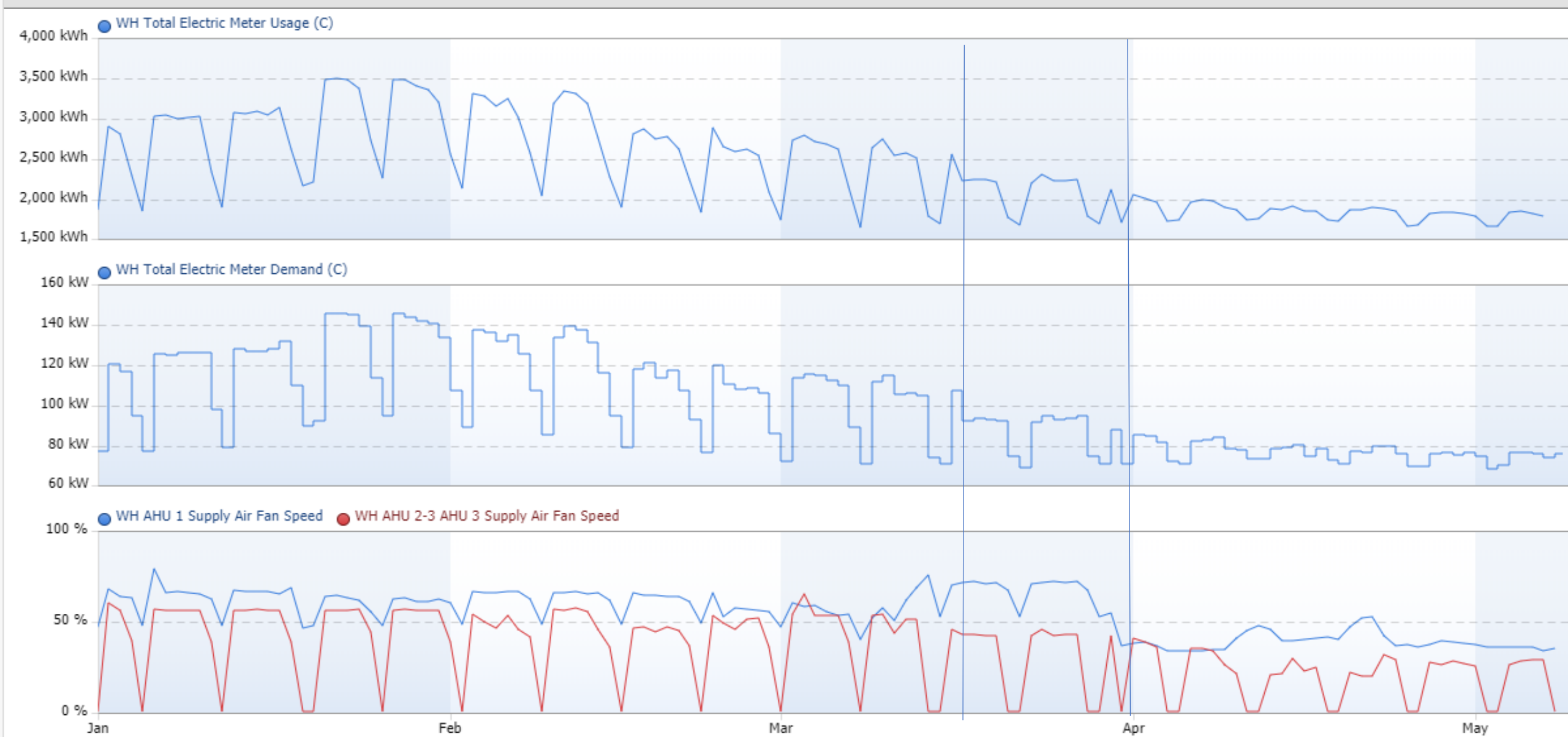
VAV Summary Tech View

VAV summary screen

	Zone Temp	Zone Setpoint	Reheat Valve	Discharge Air Temp	▼ Damper Position	Supply Flow	Supply Flow Setpoint
4-2R	72.9 deg F	72.0	0 %	59.0 deg F	100 %	409.5 cfm	1,425.0 cfm
4-15R	72.7 deg F	72.0	0 %	58.4 deg F	100 %	314.5 cfm	781.5 cfm
4-16R	70.8 deg F	72.0	54 %	59.9 deg F	100 %	384.6 cfm	375.0 cfm
4-24R	74.7 deg F	72.0	0 %	59.7 deg F	100 %	240.0 cfm	900.0 cfm
4-29R	75.1 deg F	72.0	0 %	??? -80.1 deg F	100 %	197.5 cfm	400.0 cfm
4-58R	73.1 deg F	72.0	0 %	59.8 deg F	100 %	671.5 cfm	725.0 cfm
4-13R	74.5 deg F	72.0	1 %	58.5 deg F	100 %	116.0 cfm	1,050.0 cfm
4-6R	71.9 deg F	72.0	0 %	59.2 deg F	59 %	111.8 cfm	108.0 cfm
4-11R	71.5 deg F	72.0	11 %	58.3 deg F	83 %	517.8 cfm	500.0 cfm
4-43R	71.1 deg F	72.0	16 %	60.6 deg F	59 %	490.0 cfm	475.0 cfm
4-31R	72.3 deg F	72.0	1 %	60.1 deg F	52 %	503.1 cfm	498.7 cfm
4-14R	71.5 deg F	72.0	9 %	58.3 deg F	46 %	459.9 cfm	450.0 cfm
4-45R	70.2 deg F	70.0	1 %	61.3 deg F	43 %	304.0 cfm	300.0 cfm
4-60R	72.7 deg F	72.0	0 %	59.7 deg F	40 %	290.6 cfm	282.4 cfm
4-19R	71.3 deg F	72.0	47 %	67.2 deg F	35 %	154.1 cfm	150.0 cfm
4-5R	73.4 deg F	74.0	43 %	63.3 deg F	13 %	12.6 cfm	10.0 cfm
4-1R	72.2 deg F	72.0	0 %	66.9 deg F	0 %	16.5 cfm	0.0 cfm
4-3R	75.1 deg F	72.0	0 %	72.6 deg F	0 %	0.0 cfm	0.0 cfm
4-4R	72.8 deg F	72.0	0 %	72.7 deg F	0 %	20.6 cfm	0.0 cfm
4-7R	74.9 deg F	72.0	0 %	73.9 deg F	0 %	9.5 cfm	0.0 cfm
4-8R	76.7 deg F	72.0	0 %	73.9 deg F	0 %	111.7 cfm	0.0 cfm
4-10R	73.7 deg F	72.0	0 %	59.3 deg F	0 %	0.0 cfm	0.0 cfm
4-12R	75.1 deg F	72.0	0 %	71.4 deg F	0 %	16.1 cfm	0.0 cfm
4-17R	75.0 deg F	72.0	0 %	75.0 deg F	0 %	0.0 cfm	0.0 cfm
4-20R	74.1 deg F	72.0	0 %	61.3 deg F	0 %	0.0 cfm	0.0 cfm
4-21R	76.5 deg F	72.0	0 %	74.2 deg F	0 %	0.0 cfm	0.0 cfm
4-22R	75.2 deg F	72.0	0 %	71.6 deg F	0 %	0.0 cfm	0.0 cfm
4-23R	77.1 deg F	72.0	0 %	76.2 deg F	0 %	2.9 cfm	0.0 cfm
4-25R	75.9 deg F	72.0	0 %	73.8 deg F	0 %	22.7 cfm	0.0 cfm



Welch Hall energy savings: LED smart lighting connected to BAS



4MWh Battery Storage

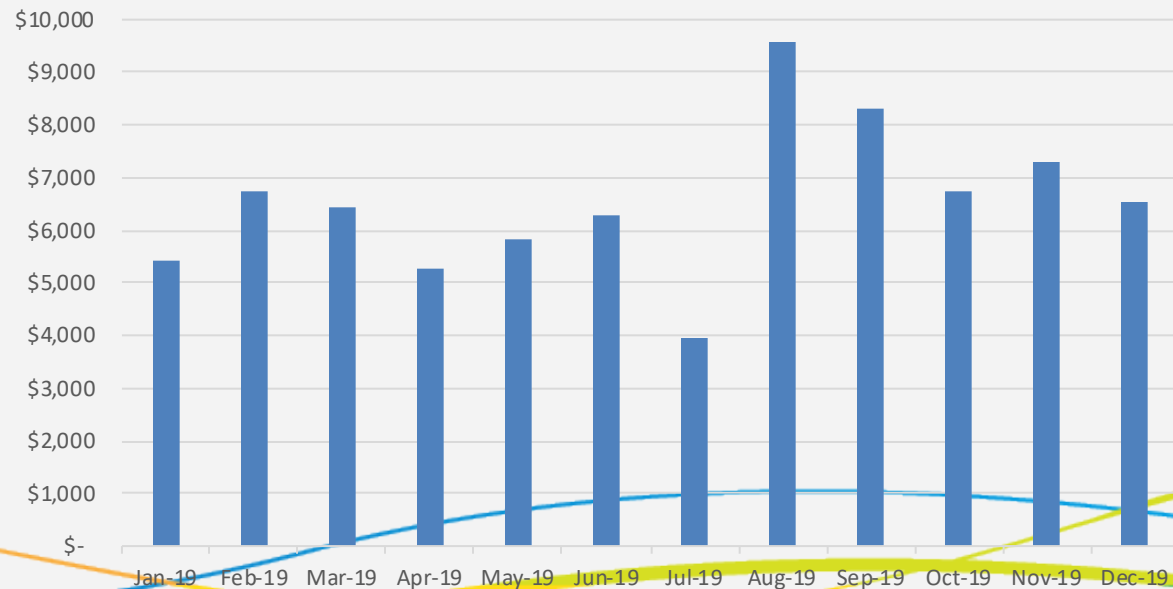
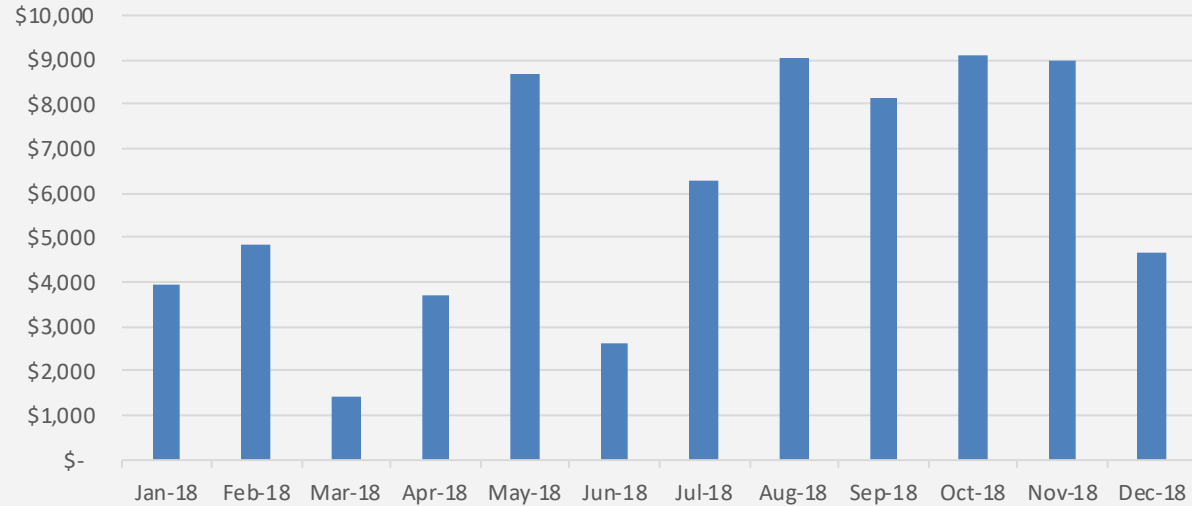


- One of largest “behind-the-meter” storage projects in Southern California
- Less than 2000 ft²
- Saves \$3-7K/mo in demand-charges
- 300-500 kW peak demand per month, 4.8 MW per year
- \$80,000 annual utility cost savings
- uses Athena, AI software that predicts weather patterns and campus loads



Savings to Date

Month	Total Savings
Jan-18	\$ 3,932
Feb-18	\$ 4,827
Mar-18	\$ 1,451
Apr-18	\$ 3,710
May-18	\$ 8,680
Jun-18	\$ 2,631
Jul-18	\$ 6,291
Aug-18	\$ 9,042
Sep-18	\$ 8,139
Oct-18	\$ 9,105
Nov-18	\$ 8,987
Dec-18	\$ 4,686
Total 2018	\$ 71,481
Jan-19	\$ 5,422
Feb-19	\$ 6,736
Mar-19	\$ 6,442
Apr-19	\$ 5,267
May-19	\$ 5,813
Jun-19	\$ 6,298
Jul-19	\$ 3,936
Aug-19	\$ 9,573
Sep-19	\$ 8,290
Oct-19	\$ 6,757
Nov-19	\$ 7,287
Dec-19	\$ 6,561
Total 2019	\$ 78,381
Grand total 2 years	\$ 149,862



Usage comparison

	Jun '17	Jun '18	Jul '18	Aug '18	Sep '18	Oct '18	Nov '18	Dec '18	Jan '19	Feb '19	Mar '19	Apr '19	May '19	Jun '19
Total kWh used	1,434,960	1,192,080	1,341,300	1,380,420	1,566,630	1,388,100	1,467,570	1,243,950	1,161,790	1,328,400	1,245,990	1,379,520	1,567,740	1,328,130
Number of days	30	29	30	29	32	29	33	31	29	32	29	30	32	29
Appx. average kWh used/day	47,832	41,106	44,710	47,600	48,957	47,865	44,471	40,127	40,061	41,512	42,965	45,984	48,991	45,797

Details of your new charges

Your rate: TOU-8-D (Direct Access)

Billing period: 06/04/19 to 07/03/19 (29 days)

Delivery charges - Cost to deliver your electricity

Facilities rel demand	2,640 kW x \$11.95000	\$31,548.00
Demand-Summer		
On peak	2,280 kW x \$8.68000	\$19,790.40
Energy-Summer		
On peak	199,530 kWh x \$0.01835	\$3,661.38
Mid peak	65,730 kWh x \$0.01835	\$1,206.15
Off peak	1,062,870 kWh x \$0.01835	\$19,503.66
Customer charge		\$230.66
Power factor adj	1,200 kVar x \$0.60000	\$720.00

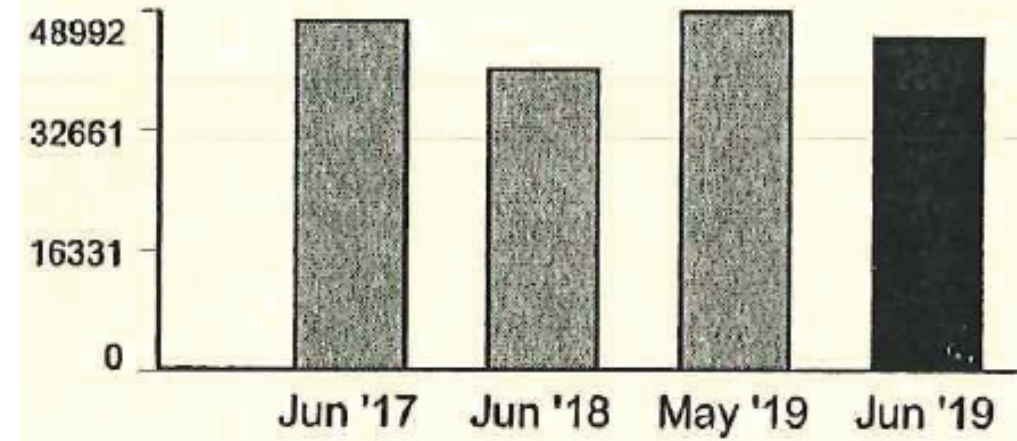
Direct Access cost responsibility surcharge *

DA CRS DWR bond	1,328,130 kWh x \$0.00503	\$6,680.49
PCIA	1,328,130 kWh x \$0.00005	\$66.41
CTC	1,328,130 kWh x \$0.00039	\$517.97

Other charges or credits

Generation Municipal Surcharge		\$1,090.49
Subtotal of your new charges		\$85,015.61
UUT exempt		
Your new charges		\$85,015.61

Your daily average electricity usage (kWh)



View by: **Billing Period** ▼

February 03, 2020 → March 03, 2020 ▼

**Pre
Covid**

Energy
1,384 MWh

Demand
2.41 MW

1.15 MW

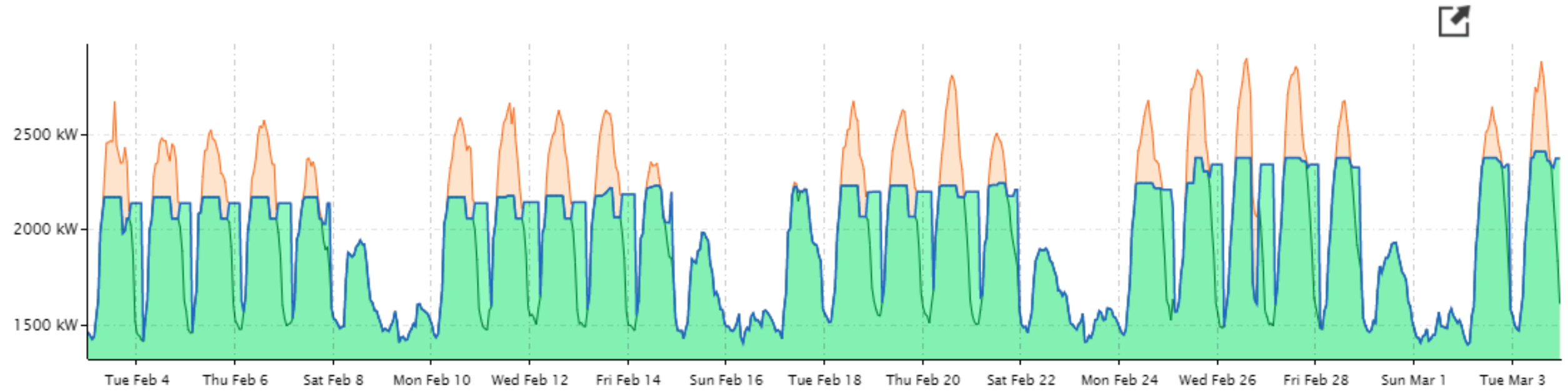
Maximum Demand

Minimum Demand

Show on graph

Show on graph

— Optimized Utility Demand ● Utility Energy Usage ● PowerStore Discharge ● PowerStore Charge



View by: **Billing Period** ▼

March 04, 2020 → April 01, 2020 ▼

Pre and Post Covid

Energy

1,107 MWh

Demand

2.37 MW

Maximum Demand

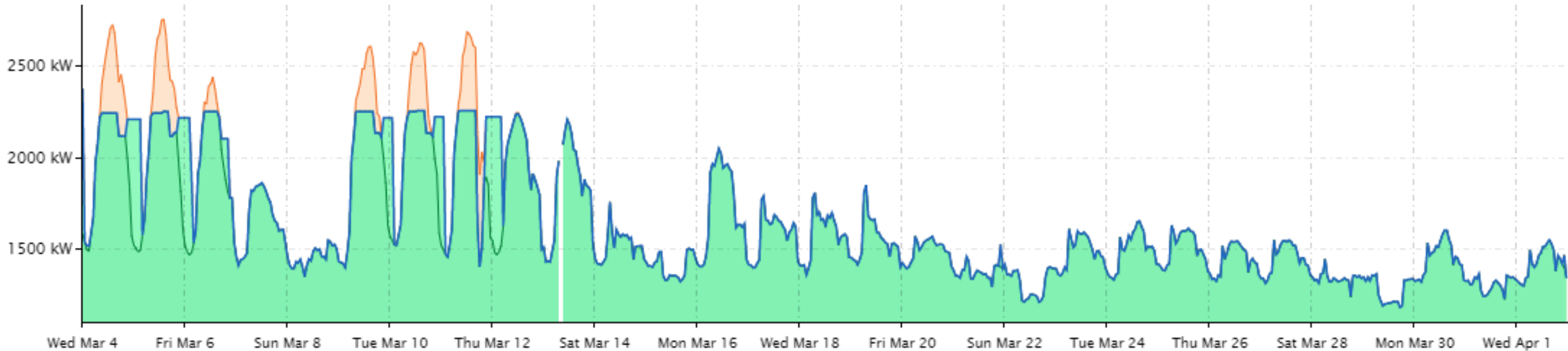
Show on graph

1.16 MW

Minimum Demand

Show on graph

— Optimized Utility Demand ● Utility Energy Usage ● PowerStore Discharge ● PowerStore Charge



View by: **Billing Period** ▼

April 02, 2020 → May 03, 2020 ▼

Post Covid

Energy

1,001 MWh

Demand

1.48 MW

931 kW

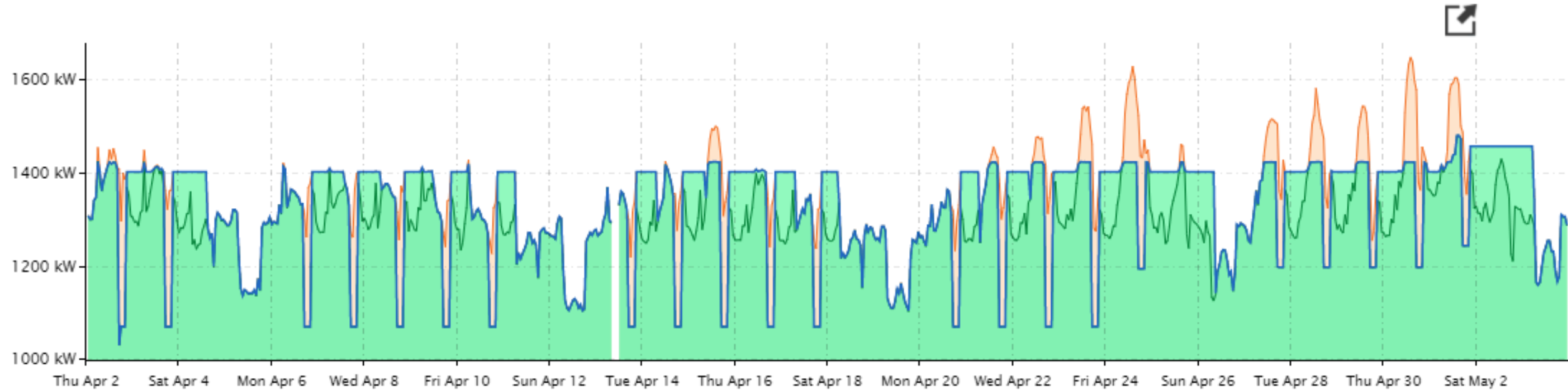
Maximum Demand

Show on graph

Minimum Demand

Show on graph

— Optimized Utility Demand ● Utility Energy Usage ● PowerStore Discharge ● PowerStore Charge



Thank You

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